The Inevitability of Soybean Cyst Nematode

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NSERC Senior Industrial Research Chair

"Cutting Through the BS"
Soils and Crops
Saskatoon, Saskatchewan
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INTERNATIONAL YEAR OF PLANT HEALTH 2020

University of Manitoba

2015 Soyben Disease Losses U.S. and Ontario

Table 1. Estimated soybean yield losses from diseases in the top 28 U.S. soybean-producing states and Ontario, Canada, in 2015.

Disease/Pathogen	2015 Estimated Yield Losses for U.S. (thousands of bushels)	2015 Estimated Yield Losses for Ontario (thousands of bushels)
Root Rots and Seedling Blights		
Soybean cyst nematode	109,288	3,696
Seedling diseases (caused by species of *Fusarium*, *Pythium*, or *Rhizoctonia*)	62,948	2,957
Root-knot nematode	12,366	0
Reniform nematode	4,438	0
Other nematodes (lesion, Columbia lance, sting, stubby root)	1,465	148
Leaf and Aboveground Diseases		
Septoria brown spot	26,868	37
Frogeye leaf spot	17,662	15
Cercospora leaf blight	12,840	0
Downy mildew	4,383	7
Bacterial diseases (bacterial blight and bacterial pustule)	2,774	4
Virus Diseases (AMV, BPMV, SbDV, SMV, SVNV, TRSV, TSV)*	2,602	74
Other leaf and aboveground diseases (Phyllosticta leaf spot, target spot)	2,427	0
Purple seed stain	1,594	15
Rhizoctonia aerial blight	652	0
Soybean rust	157	0
Stem Diseases		
Sudden death syndrome	43,776	2,218
Sclerotinia stem rot (also known as white mold, caused by *Sclerotinia sclerotiorum*)	40,083	2,957
Phytophthora root and stem rot	28,275	1,479
Charcoal rot	20,808	15
Brown stem rot	17,389	74
Stem canker	12,349	222
Pod and stem blight	10,718	296
Anthracnose	5,188	0
Diaporthe/Phomopsis complex (seed rot)	3,612	44
Fusarium wilt and root rot	3,169	1,109
Other stem diseases (Phymatotrichopsis root rot, red crown rot, taproot decline)	2,253	0
Southern blight	523	0

*AMV = alfalfa mosaic virus, BPMV = bean pod mottle virus, SbDV = soybean dwarf virus, SMV = soybean mosaic virus, TRSV = tobacco ringspot virus, TSV = tobacco streak virus.

Cropprotectionnetwork.org

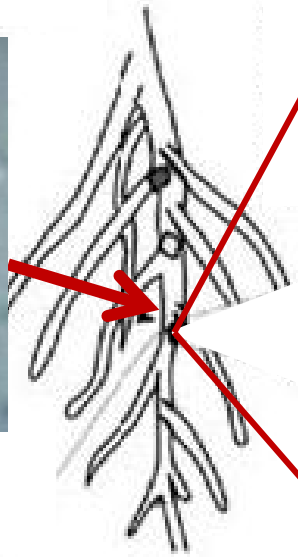
Soybean Cyst Nematode (SCN)

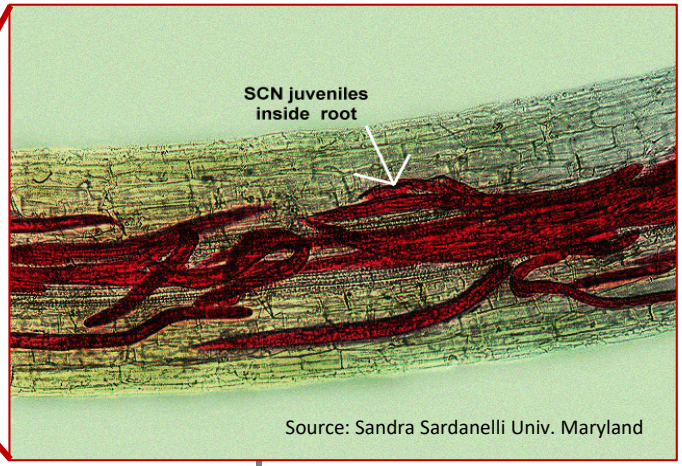
- Is a nematode (round worm) that parasitizes roots of soybean
- Like people, not all nematodes are bad, but SCN is bad

The Life of a SCN Female

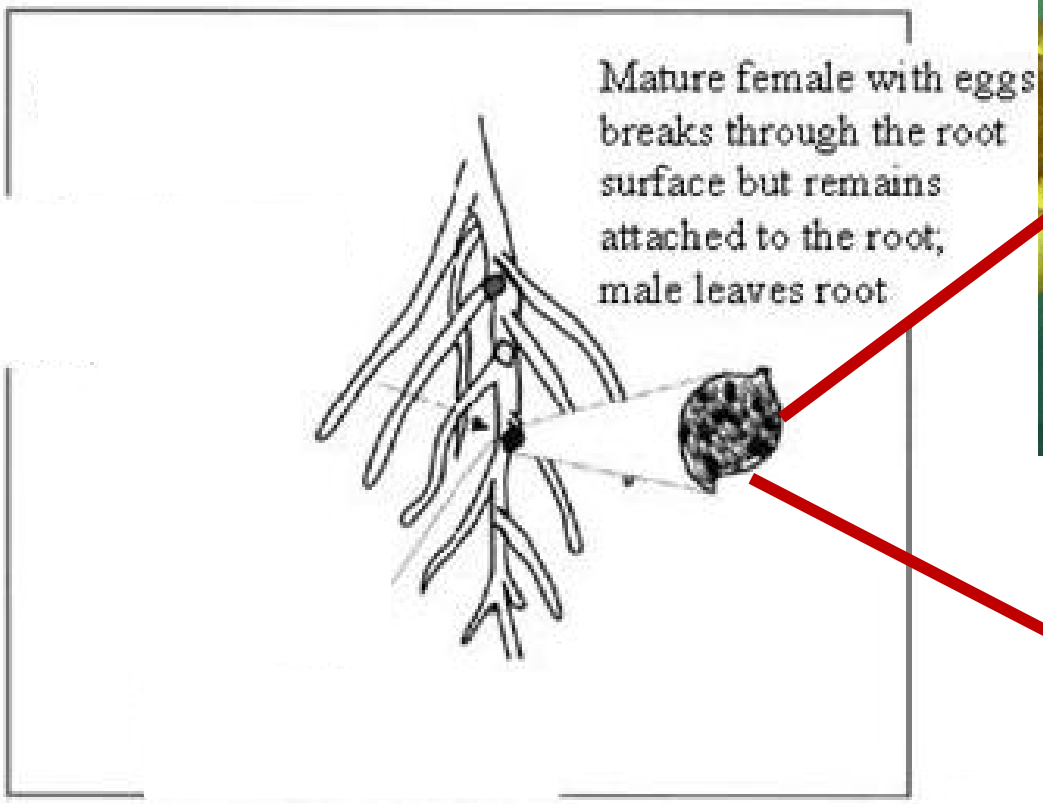
Soil

Root

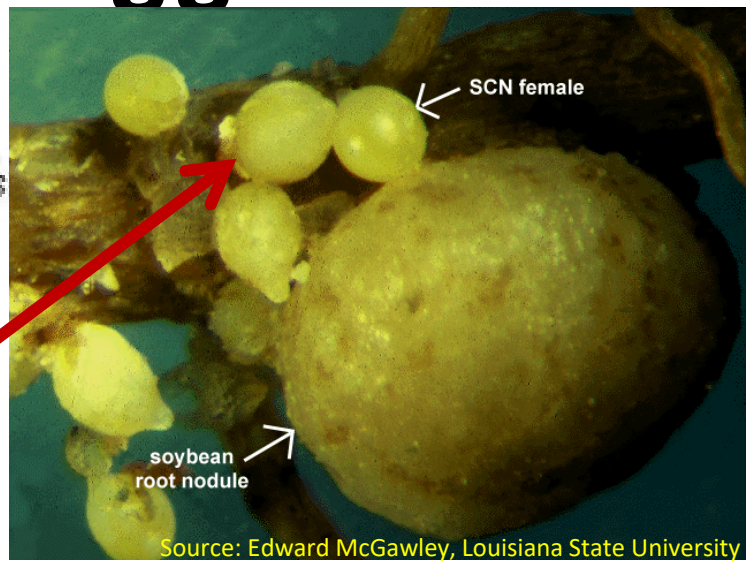


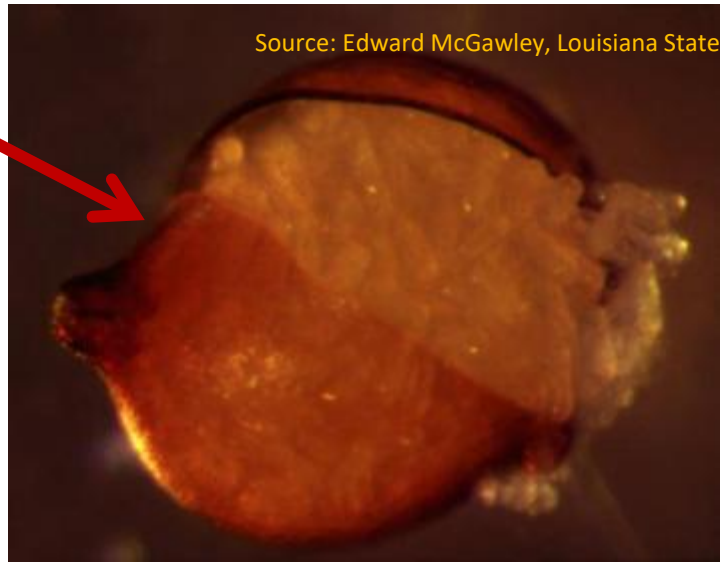


Female Settles Down to Feed and Produce Eggs

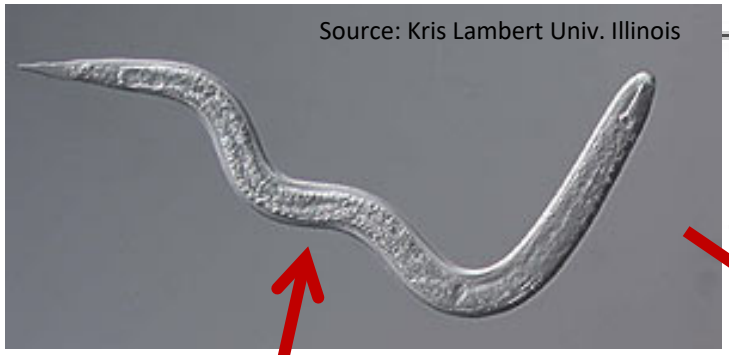


Source: Greg Tylka Iowa State Univ.





Female Becomes Cyst Eventually Rupturing and Releasing Eggs

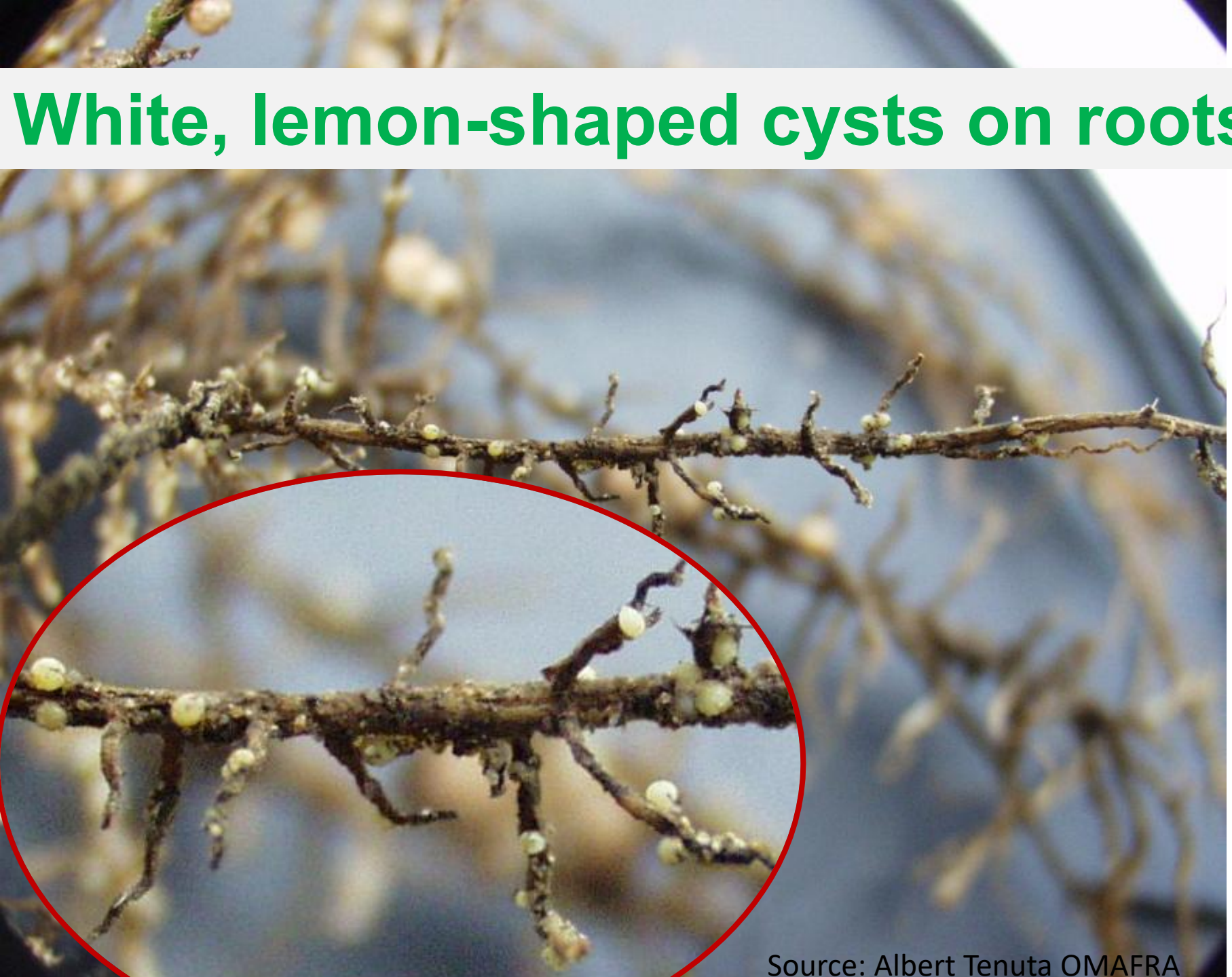


Soil

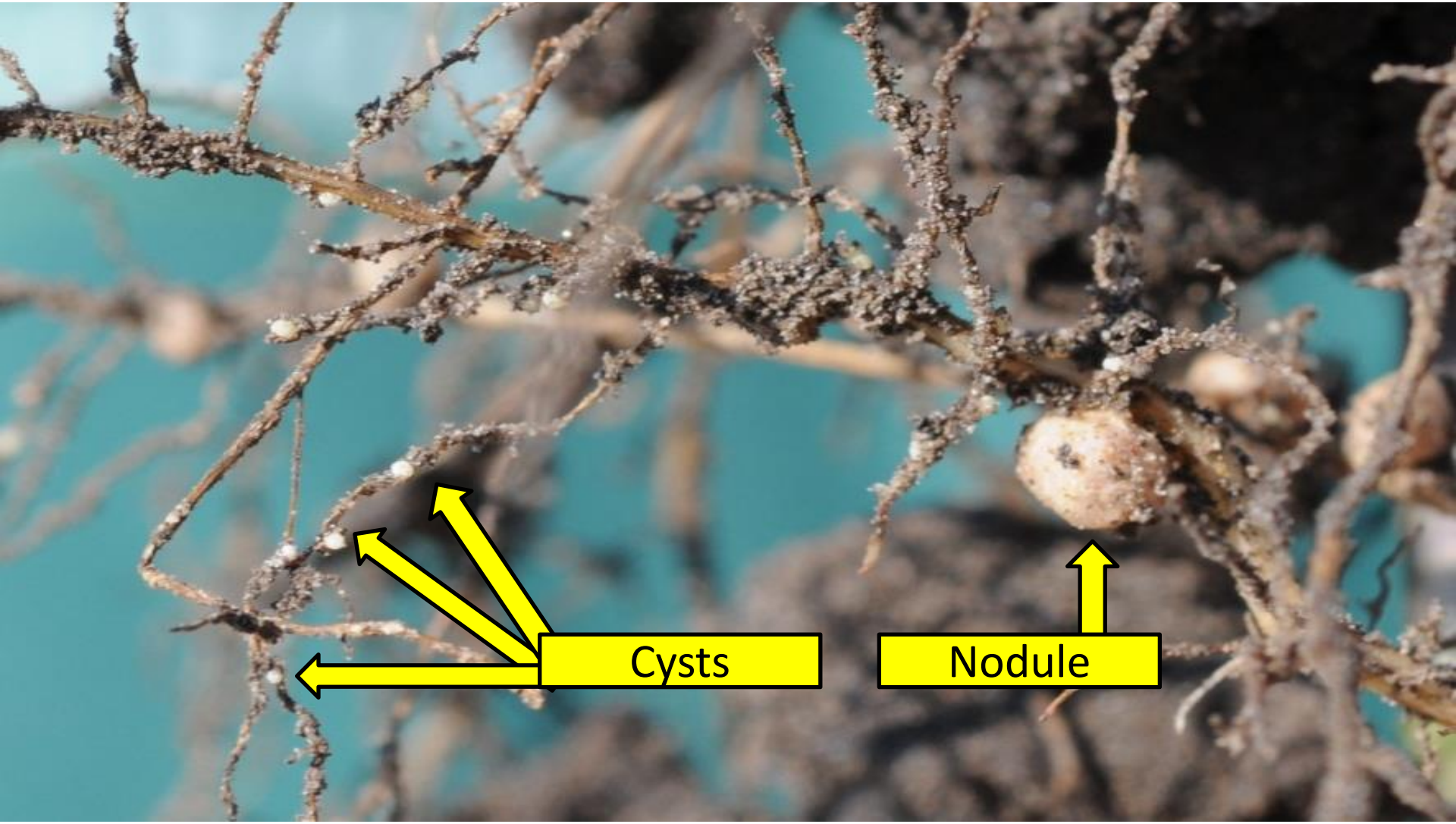
Source: Edward McGawley, Louisiana State University

Eggs released in soil, develop into juveniles

White, lemon-shaped cysts on roots



Source: Albert Tenuta OMAFRA


Cysts
Nodule

SCN is Spreading to all Soybean Areas of Canada and U.S.

- Japan in 1880
- North Carolina in 1954
- Moved rapidly from there through much of soy growing area of the U.S.
- Minnesota in 1978
- Ontario in 1987
- North Dakota in 2003

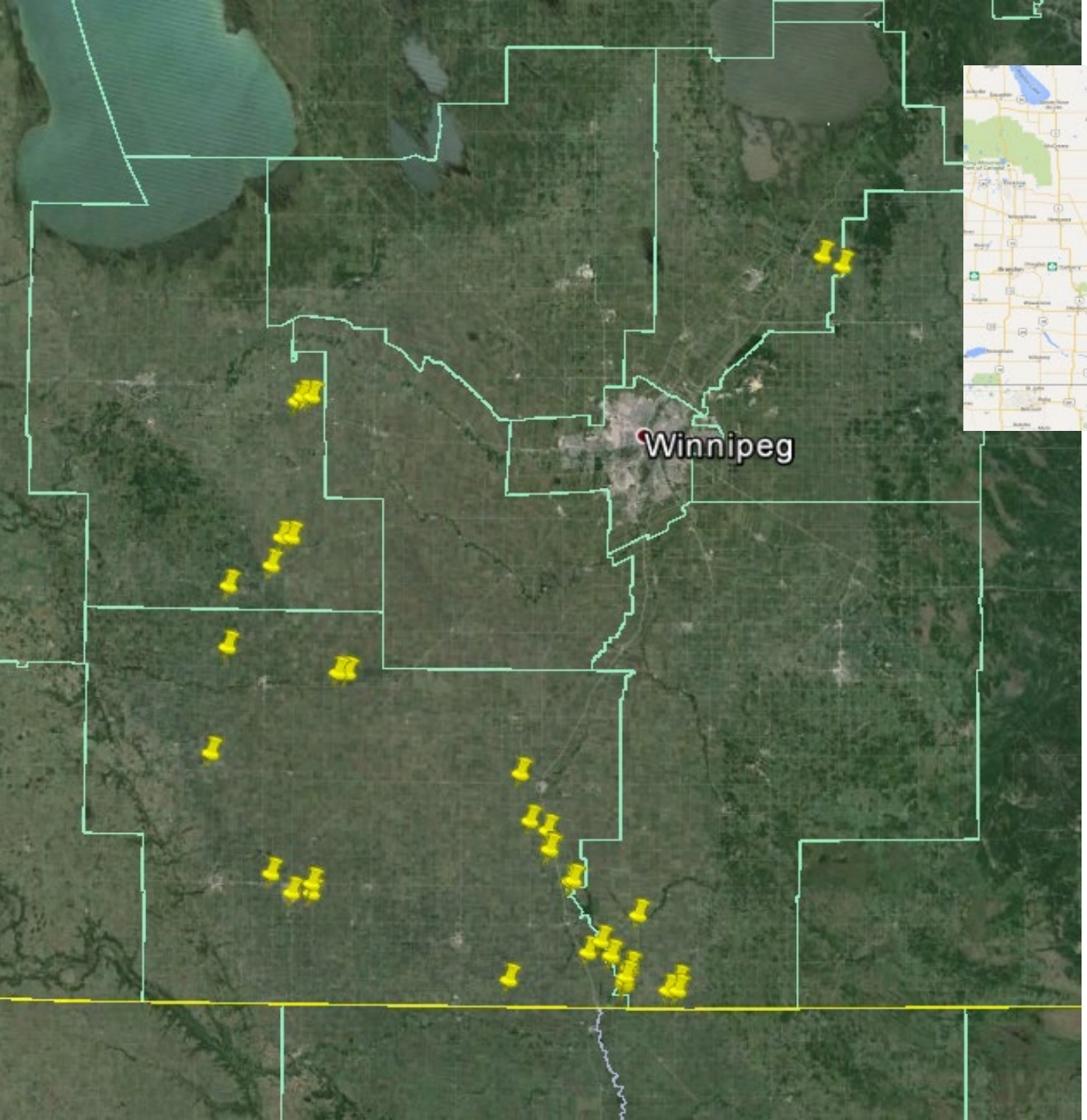
The Quick March North

SCN in Manitoba?

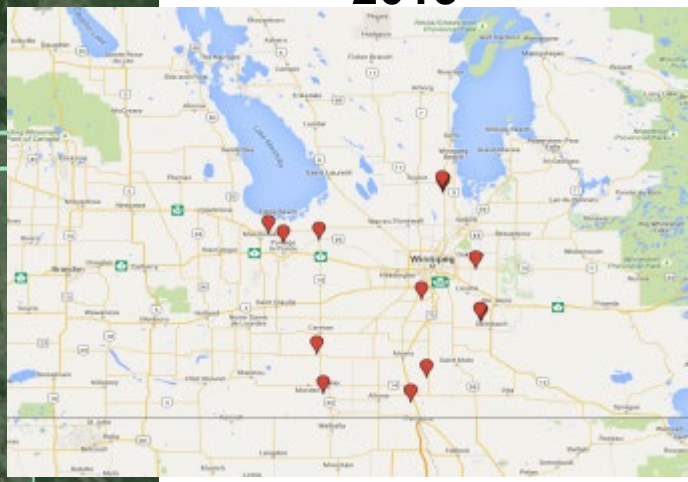
- Canadian Food Inspection Agency (CFIA) has done some survey work of random fields
- CFIA found in survey of potato soil in 2010 what seemed to be a lot of SCN in one field
- *CFIA has removed SCN as a Regulated Pest in Canada and thus will not survey fields any longer*

SCN Survey of Manitoba 2012-2015

- 76 soybean fields sampled
- > 5500 soil samples
- 487 composite samples for processing
- Priority fields based on
  - Proximity to water courses from U.S. that flood
  - Number of soybean years
  - History of dry beans
  - Sampled prone areas of fields



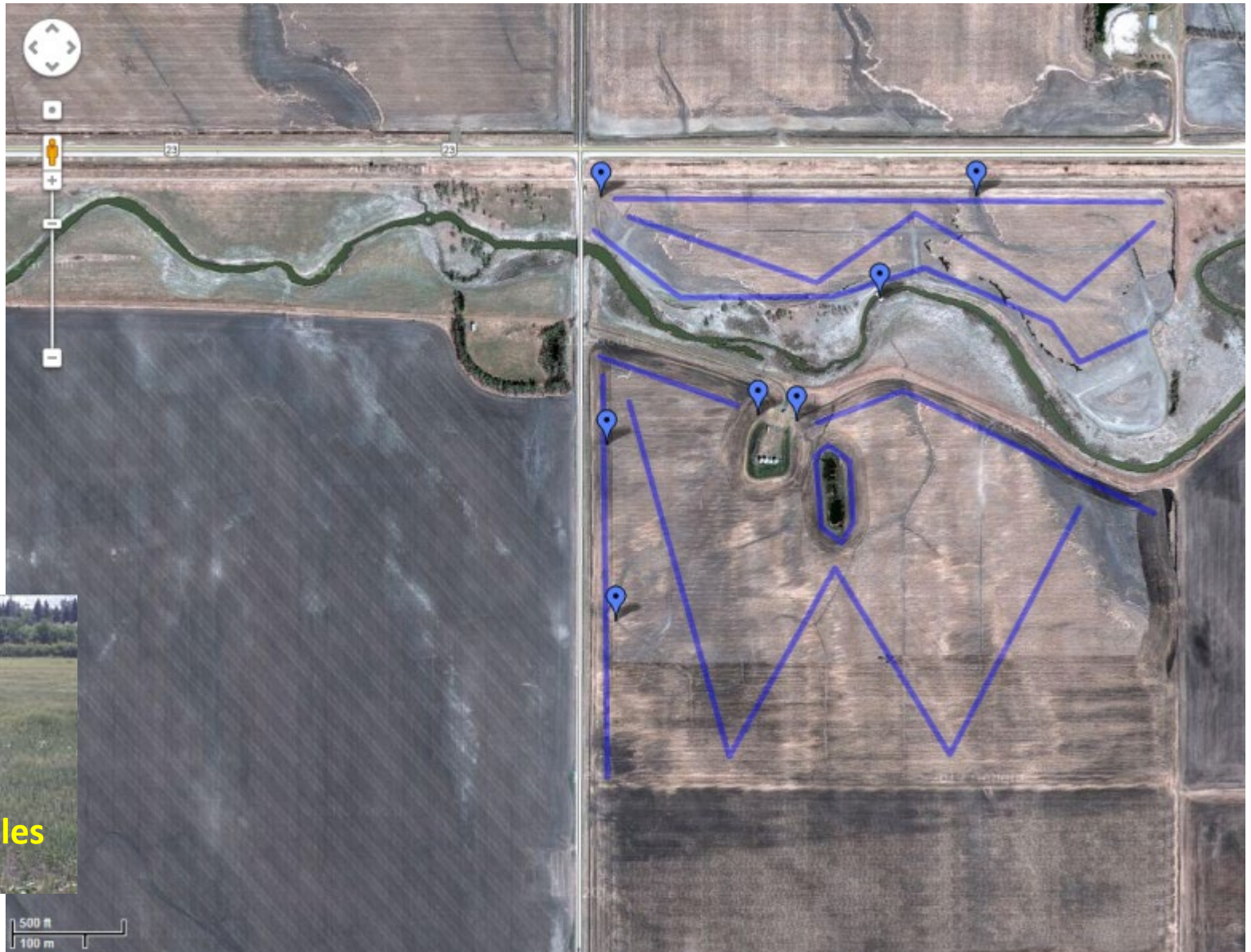
2015



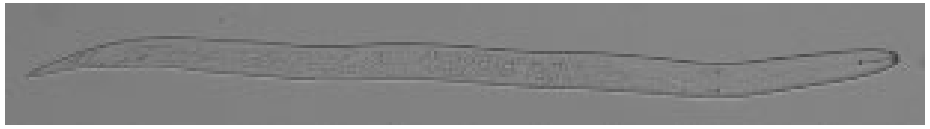
35 fields sampled Oct/Nov 2012

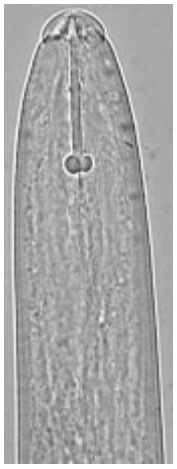
13 fields sampled July/Aug 2013

Collecting Soil Samples

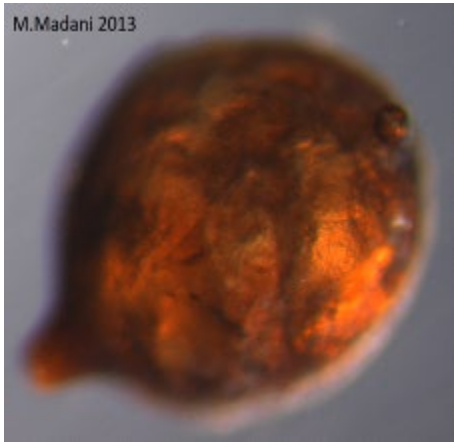


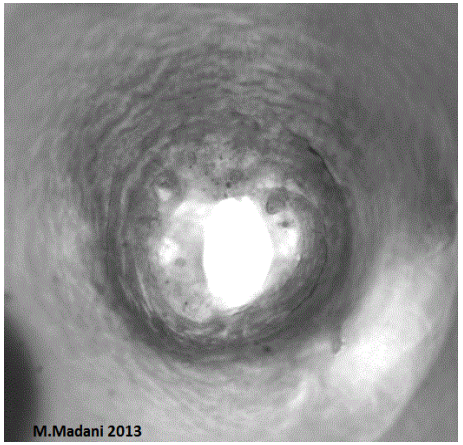
Juveniles and Cysts



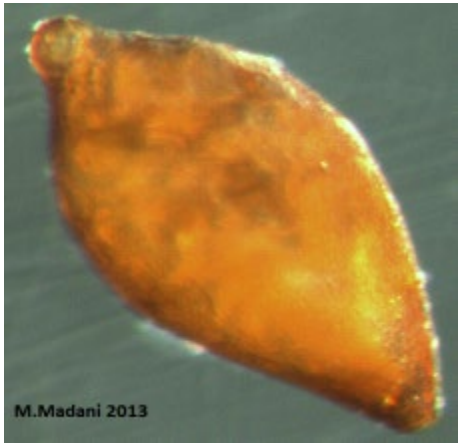


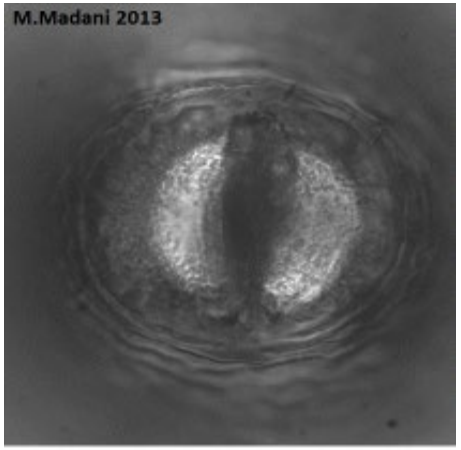
Circumfenestrate





Bifenestrate



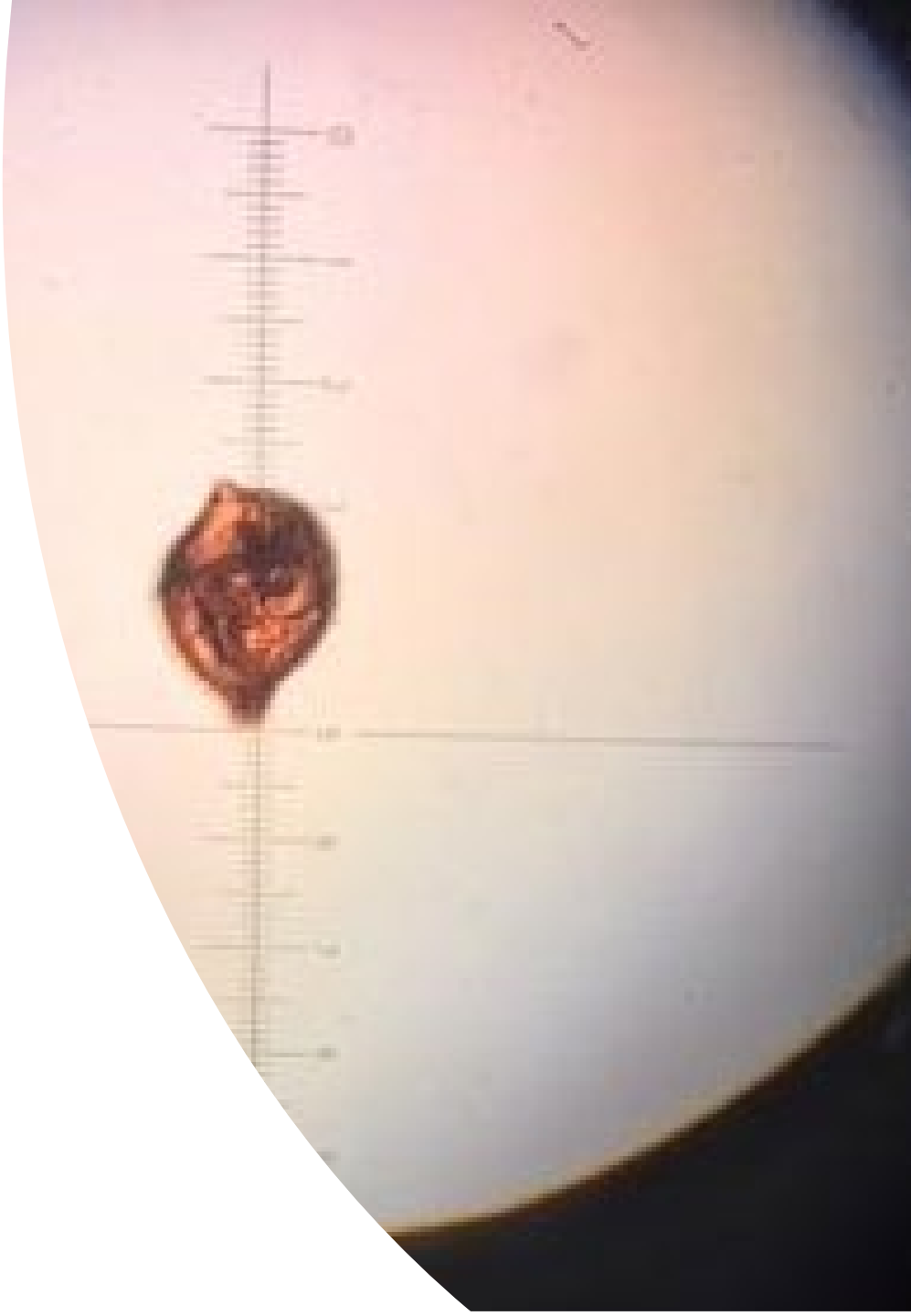


Results 2012/13

- 37 composite samples from 22 fields had cysts
- Total of 60 cysts recovered
- 26 cysts were not damaged
- 23 cysts had circumfenestrate vulval cone structures – *Cactodera*, *Punctodera*, *Betulodera*
- 3 cysts were bifenestrate – *Heterodera*

Results

- 15 circumfenestrate cysts had eggs or juveniles
- 1 bifenestrate cyst had eggs and juveniles
- ITS sequencing, species-specific PCR
- Circumfenestrate cysts ITS matched *Cactodera*
- Bifenestrate cyst ambiguous – *Heterodera* by morphology, not SCN by species primer sets, *Cactodera* by ITS sequencing

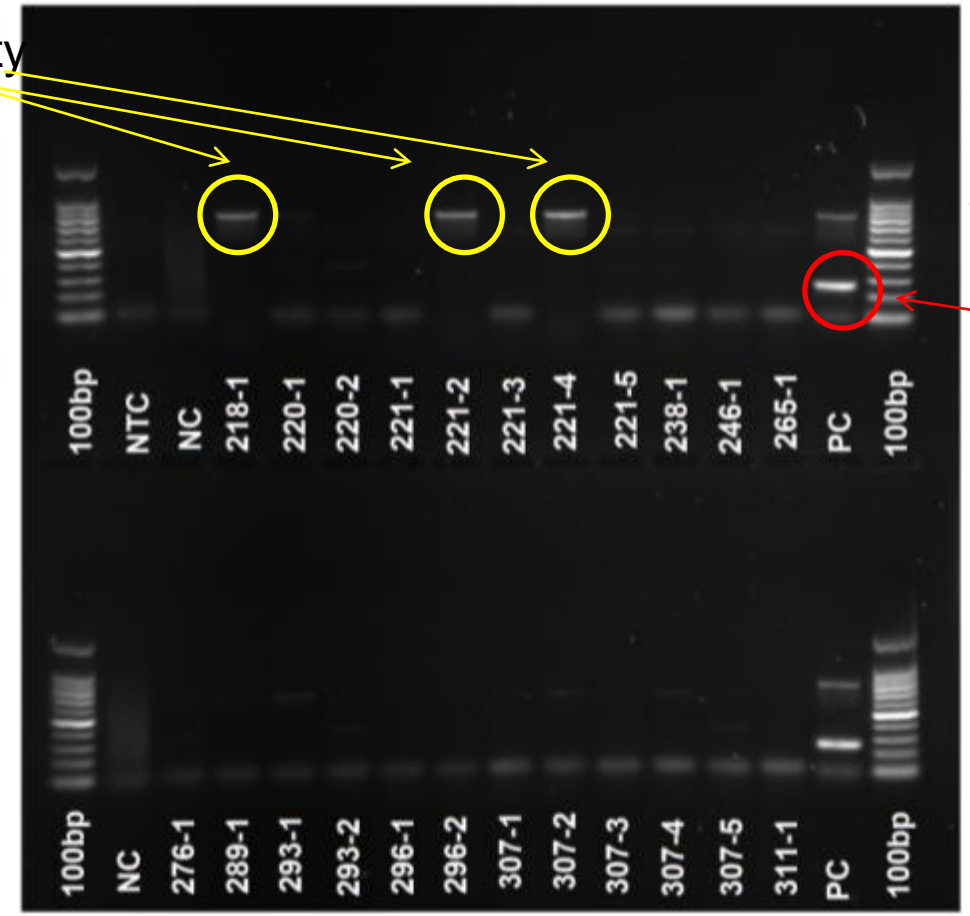


Results 2014/15

- 28 fields sampled
- 205 composite samples analyzed
- 32 samples had cysts, but only a few each
- Most cysts were round and not lemon shaped
- Cone top patterns circumfenestrate
- 6 cysts yielded DNA for analysis, failed to be SCN

Species Specific PCR for SCN in 2015

3 cysts yielding quality DNA but not positive For SCN

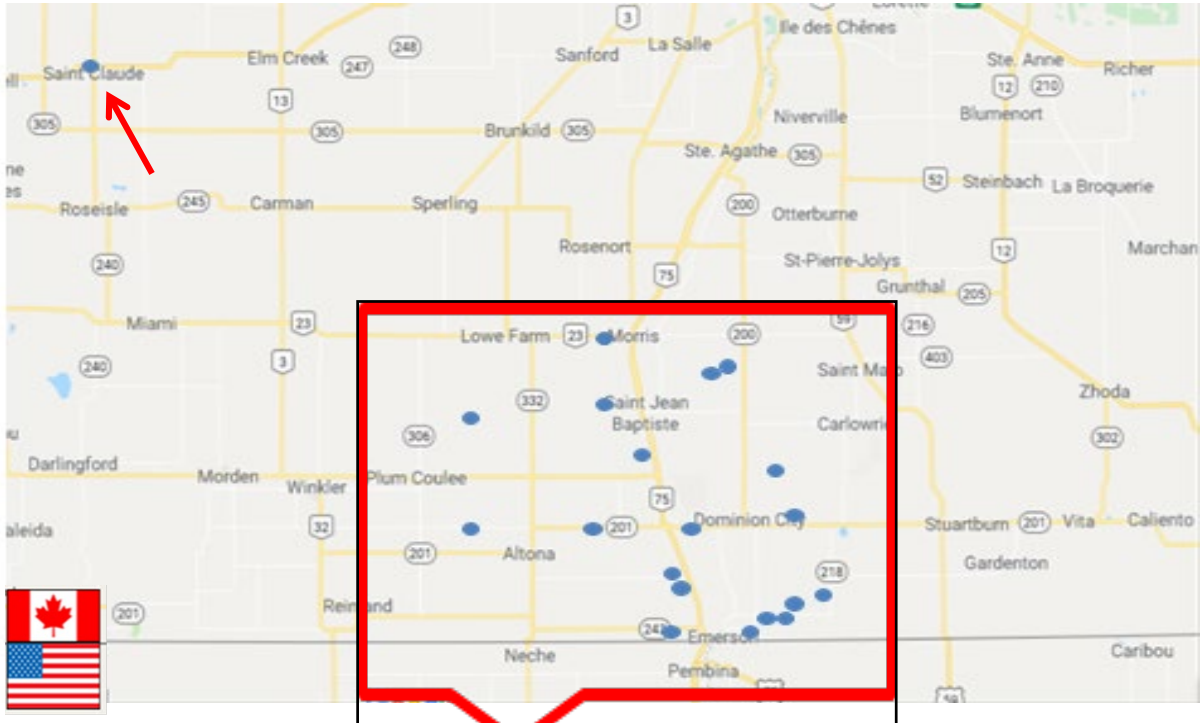


Positive control SCN yielding good DNA and giving band for SCN

Manitoba 2017/2018 SCN Survey

- Fall 2017, 30 soybean fields soil sampled
- Samples have been extracted and being analyzed now for cysts

PhD student: Nazanin Ghavami



Results 2018

- 30 commercial soybean fields were sampled
- A total of 90 composite soil samples were obtained
- Overall, 17 of the composite samples from 7 fields had nematode cysts
- One to a few cysts were recovered from each of these 17 composite samples
- In total, 42 cysts were recovered and 30 of the cysts from seven fields were brown and lemon-shaped as expected of SCN

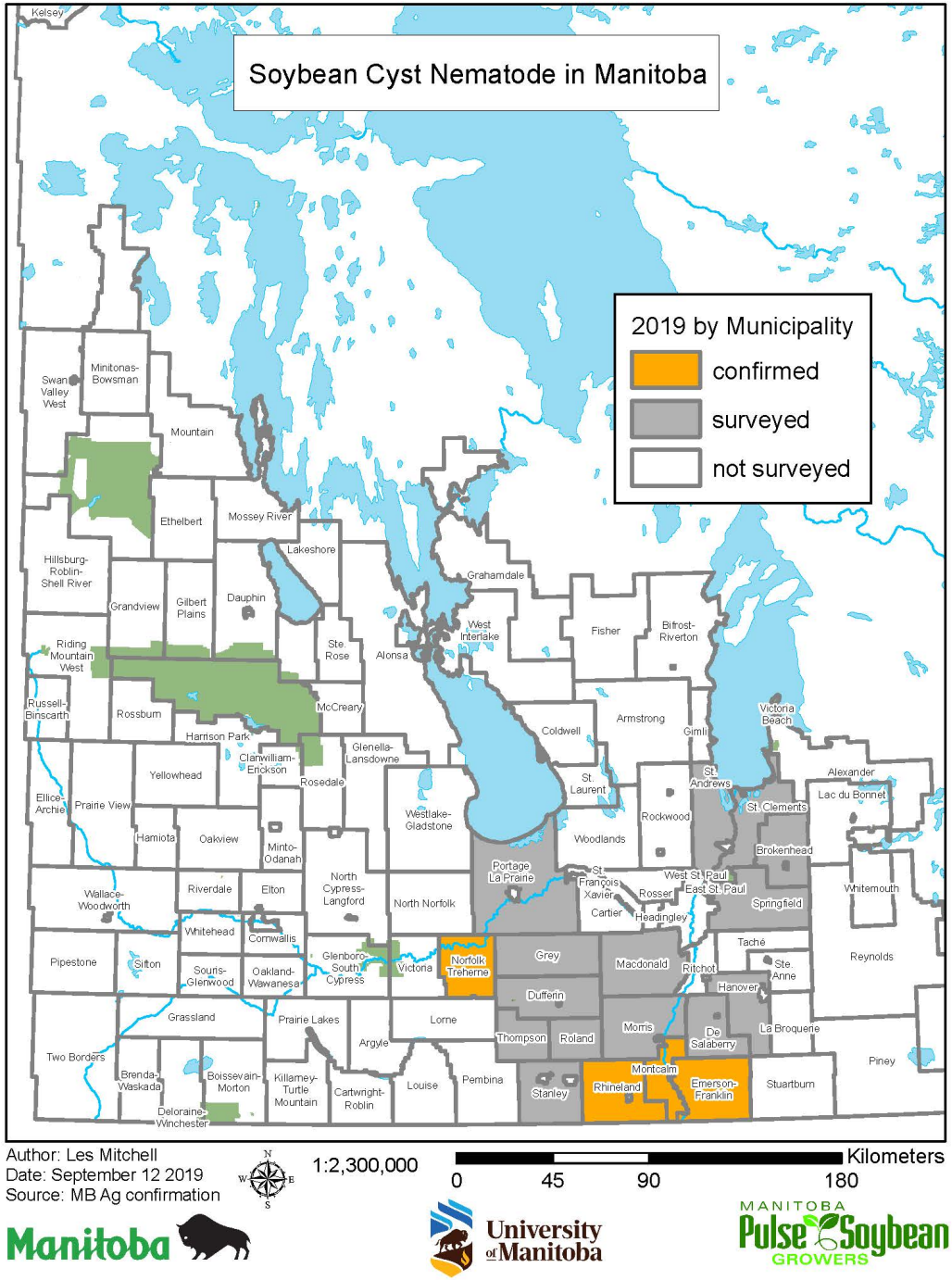
Results 2018

- Cyst numbers were 1, 2, 4, and 14 kg^{-1} soil for each of the fields
- PCR of 7-12 lemon-shaped cysts for the CoxIII gene & SCAR gene regions were SCN
- DNA sequencing of 18s and ITS genes also confirmed cysts were SCN
- Morphology of cysts and nematode juveniles also consistent with being SCN
- In 2019, soy grown on field in Norfolk Treherne

- In 2019, soy grown on field in Norfolk Treherne
- Visited the field twice and on second visit found SCN on roots of soy

Results 2019

Map Summary


Soybean Cyst Nematode in Manitoba
2019 by Municipality
confirmed
surveyed
not surveyed
Kelsey
Swan Valley West
Minitonas-Bowsman
Mountain
Ethelbert
Mossey River
Lakeshore
Hillsburg-Roblin-Shell River
Grandview
Gilbert Plains
Dauphin
Grahamdale
West Interlake
Fisher
Bifrost-Riverton
Riding Mountain West
Ste. Rose
Alonsa
Russell-Binscarth
Rossburn
McCreary
Harrison Park
Clanwilliam-Erickson
Glenella-Lansdowne
Coldwell
Armstrong
Gimli
Victoria Beach
Yellowhead
Rosedale
St. Laurent
St. Andrews
Alexander
Lac du Bonnet
Ellice-Archie
Prairie View
Westlake-Gladstone
Rockwood
St. Clements
Hamiota
Oakview
Minto-Odanah
Woodlands
Brokenhead
Portage La Prairie
St. François Xavier
West St. Paul
East St. Paul
Springfield
Whitemouth
Wallace-Woodworth
Riverdale
Elton
North Cypress-Langford
North Norfolk
Rosser
Cartier
Headingley
Whitehead
Cornwallis
Taché
Pipestone
Silton
Souris-Glenwood
Oakland-Wawanesa
Glenboro-South Cypress
Victoria
Norfolk Treherne
Grey
Macdonald
Ritchot
Ste. Anne
Reynolds
Dufferin
Hanover
Grassland
Prairie Lakes
Lorne
Thompson
Roland
Morris
De Salaberry
La Broquerie
Two Borders
Argyle
Brenda-Waskada
Boissevain-Morton
Killarney-Turtle Mountain
Cartwright-Roblin
Louise
Pembina
Stanley
Rhineland
Montcalm
Emerson-Franklin
Stuartburn
Piney
Deloraine-Winchester
Author: Les Mitchell
Date: September 12 2019
Source: MB Ag confirmation
1:2,300,000
Kilometers
0
45
90
180
Manitoba
University of Manitoba
MANITOBA Pulse Soybean GROWERS

On-going

- SCN positive fields resampled in 2020
- Lots of soil brought to lab
- Soy grown in soil to show reproduction on roots
- Build population to determine HG type of SCN population here

Damage Patches in Fields

Source: American Phytopathology Society

Source: Albert Tenuta OMAFRA

Can be Confused with Drown Outs

Source: Albert Tenuta OMAFRA

Can be Confused with Iron Chlorosis

Source: Jay Goos North Dakota State University

Effects of SCN on Soybean

What does it do?

- Takes away nutrients
- Water update disrupted
- Interferes with nodulation
- Damages roots (holes)

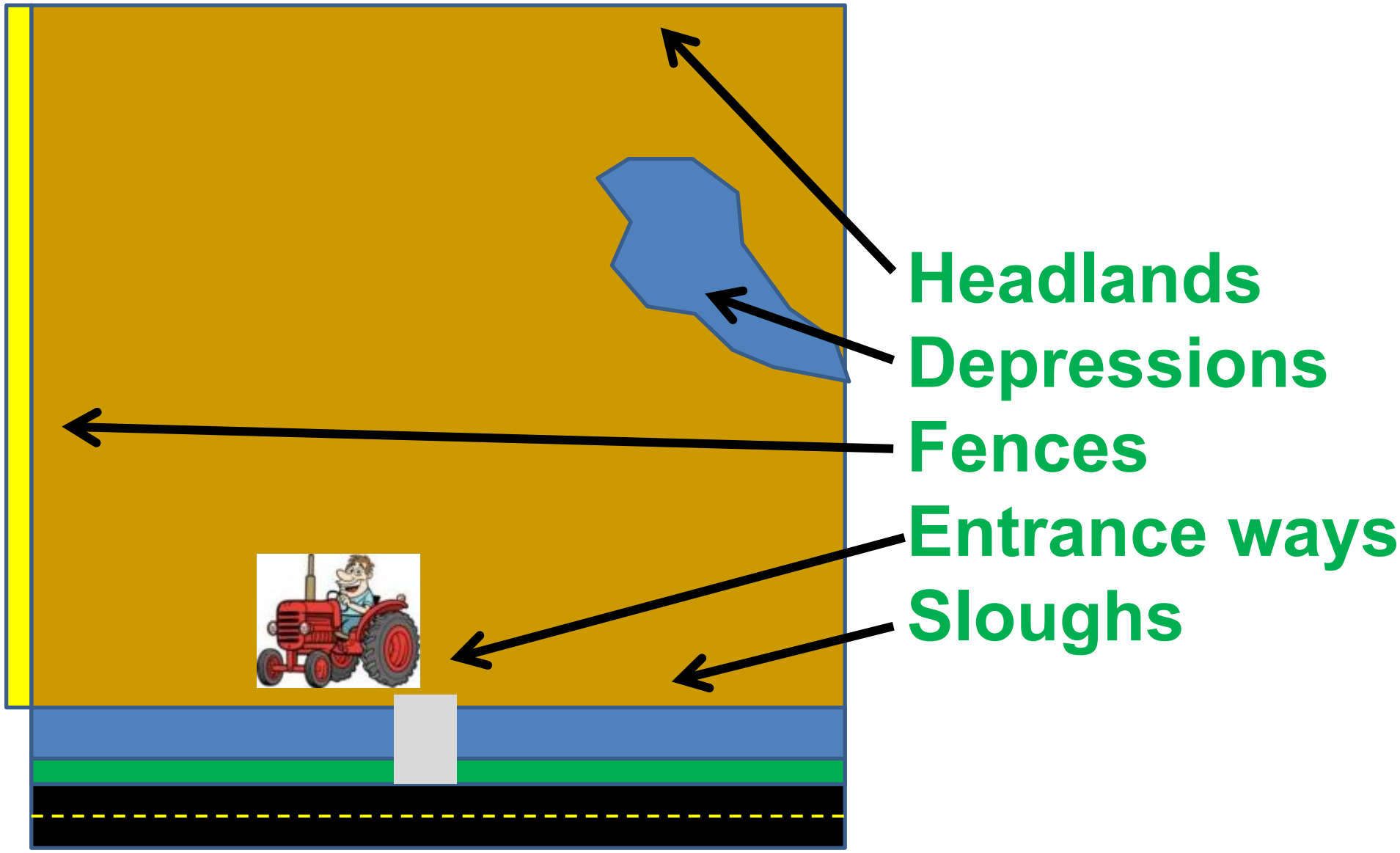
Field symptoms?

- **Yellowed plants**
  - **Resembles Iron Chlorosis**
- **Stunted plants**
  - **Uneven height**
- **Early maturity**
- **Reduction of yield**
- **Fewer pods**
- **Damage shows earlier on sands**

Avoid Host Plants in Fields

Crop Plants	Weed Plants
Adzuki Bean	American Vetch
Alsike Clover	Carolina Vetch
Bird's-foot Trefoil	Common Chickweed
Common Vetch	Common Mullein
Cowpea/Black-eyed Pea	Field Pennycress
Crimson Clover	Hemp Sesbania
Crownvetch	Henbit
Pinto, Navy, Cranberry, Black, Kidney,	Hop Clovers
Great Northern, Snap Bean	Milk Vetch
Hairy Vetch	Mouse-ear Chickweed
Lespedezas	Pokeweed
Lima Bean	Purple Deadnettle
Lupines	Purslane
Mung Bean	Shepherd's Purse
Pea	Wild Mustard
Soybean	Winged Pigweed
Sweet Clover	Wood Vetch

Risk Areas in Fields



Prevent Soil Movement Between Fields

- Purchase clean used equipment
- Wash implements and tires between fields
- Don’t drive pickups between fields
- Clean footwear

Source: Greg Tylka Iowa State Univ.

Source: Sandra Sardanelli Univ. Maryland

Prevent Birds From Landing on Fields

Use Resistant Soy Varieties

Resistant Varieties
Manitoba Seed Guide

HERBICIDE TOLERANT SOYBEANS ◆ VARIETY DESCRIPTIONS ◆ EASTERN MANITOBA

Manitoba Maturity Zone	Company Maturity Group	Variety	Type	Average DTM +/- Check†	Yield % Check	Site Years Tested	Hilum Colour	IDC		Resistance	
								Rating (1–5)	Group	SCN	PRR
Very Early-Season Zone	000.8	LS TRI8XT	R2X	-10	86	2	BL	1.9	ST	yes	1c
	000.5	NocomaR2	R2Y	-9	94	12	BL	2.0	ST	–	1c
	000.9	S0009-M2	R2Y	-9	89	12	IY	2.0	ST	–	6
	00.4	TH89004 R2X	R2X	-8	94	2	BR	1.8	ST	–	1c
	000.7	PS 00078 XRN	R2X	-7	95	8	BL	1.9	ST	yes	1c
	00.2	Devo R2X	R2X	-6	94	8	BR	1.8	ST	–	–
	000.9	RX000918	R2X	-6	103	2	BL	1.7	T	yes	1c
Early-Season Zone	00.1	P001A48X	R2X	-5	99	2	TN	1.7	T	–	1c
	00.1	PV 11s001 RR2	R2Y	-5	90	12	Y	1.9	ST	–	1c
	000.7	Karpo R2	R2Y	-5	104	2	GR	2.2	ST	–	–
	00.2	RX00218	R2X	-5	89	8	BR	1.9	ST	–	–
	000.2	Notus R2	R2Y	-5	103	8	BL	1.6	T	–	1c
	00.3	P003A97X	R2X	-5	99	2	GR	1.9	ST	yes	1k
	00.1	Torro R2	R2Y	-5	100	12	BL	2.2	ST	–	–
	00.2	NSC Redvers RR2X	R2X	-4	97	2	BL	1.9	ST	yes	1c
	000.9	PV 15s0009 R2X	R2X	-4	99	8	BL	2.0	ST	yes	1c
	00.4	NSC Culross RR2X	R2X	-3	98	2	BL	1.7	T	–	1c
	00.1	LS 001XT	R2X	-3	105	8	BL	1.7	T	yes	1k
	00.5	Lono R2	R2Y	-3	107	8	Y	2.0	ST	–	1c
	00.3	Dinero R2X	R2X	-2	97	8	IY	1.7	T	–	–
	00.4	TH 32004R2Y	R2Y	-2	102	2	BL	1.7	T	–	1c
	00.1	Prince R2X	R2X	-2	94	8	BL	1.7	T	–	1k
	00.6	S006-M4X	R2X	-2	98	8	IY	1.9	ST	–	1c
	00.5	S007-Y4	R2Y	-2	103	12	IY	2.0	ST	–	1c

SCN Emerging Issue for Dry Beans

plant disease

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https://doi.org/10.1094/PDIS-09-16-1257-PDN

DISEASE NOTES

First Report of the Soybean Cyst Nematode *Heterodera glycines* Infecting Dry Bean (*Phaseolus vulgaris* L.) in a Commercial Field in Minnesota

G. P. Yan, **A. Plaisance**, **I. Chowdhury**, **R. Baidoo**, **A. Upadhaya**, **J. Pasche**, **S. Markell**, and **B. Nelson**, North Dakota State University, Department of Plant Pathology, Fargo 58108-6050; and **S. Chen**, University of Minnesota, Department of Plant Pathology, St. Paul 55108.

- 2016 stunted patches in dark-red kidney bean field
- Roots infested with SCN females
- Soybean last grown in 2010

Sudden Death Syndrome

- First reported 1971 in Arkansas
- Disease complex of SCN with *Fusarium virguliforme*
- Occurs after first flowering
- In Minnesota and South Dakota

Westphal, A., T.S. Abney, L.J. Xing and G.E. Shaner. Sudden Death Syndrome of Soybean. 2008. *The Plant Health Instructor*. DOI:10.1094/PHI-I-2008-0102-01

Scout for SCN

- Fields more than 3 years of soybean
- Get out of the truck and walk
- 30-45 days after emergence, gently lift roots with spade, dunk in bucket of water for clay, look for females using a hand lens
- Up to 21-28 before ready for harvest
- Collect soil samples and SCN test (Agvise or Soil Ecology Lab U Manitoba)

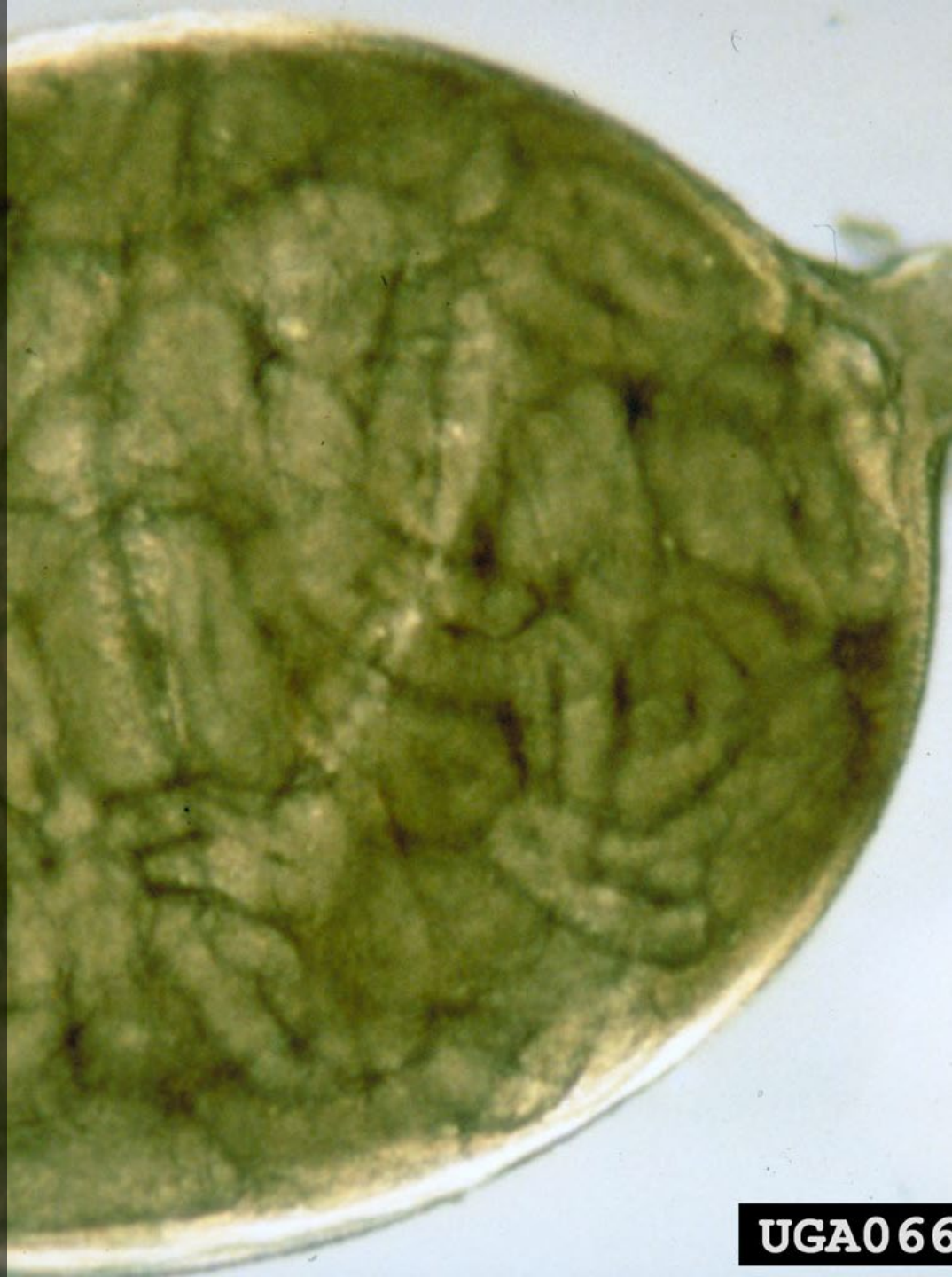
Checking Roots

http://www.nwroc.umn.edu/Cropping_Issues/2010/July_20/SoybeanCystNematodeScouting/index.htm

@soilecologyUMan

THANK YOU

- Nazanin Ghavami
- MB Agriculture, WGRF, MPSG, AAFC
- Dennis Lange
- Les Mitchell, Anastasia Kubinec
- Dr. Mehrdad Madani, Terri Fairman
- Albert Tenuta, Tom Welacky



Soybean Cyst Nematode

Warning signs:

- Areas of stunted plants, and poor canopy
- Areas of chlorotic growth
- Areas where weed control is sub optimum
- White females (i.e. cysts) on roots

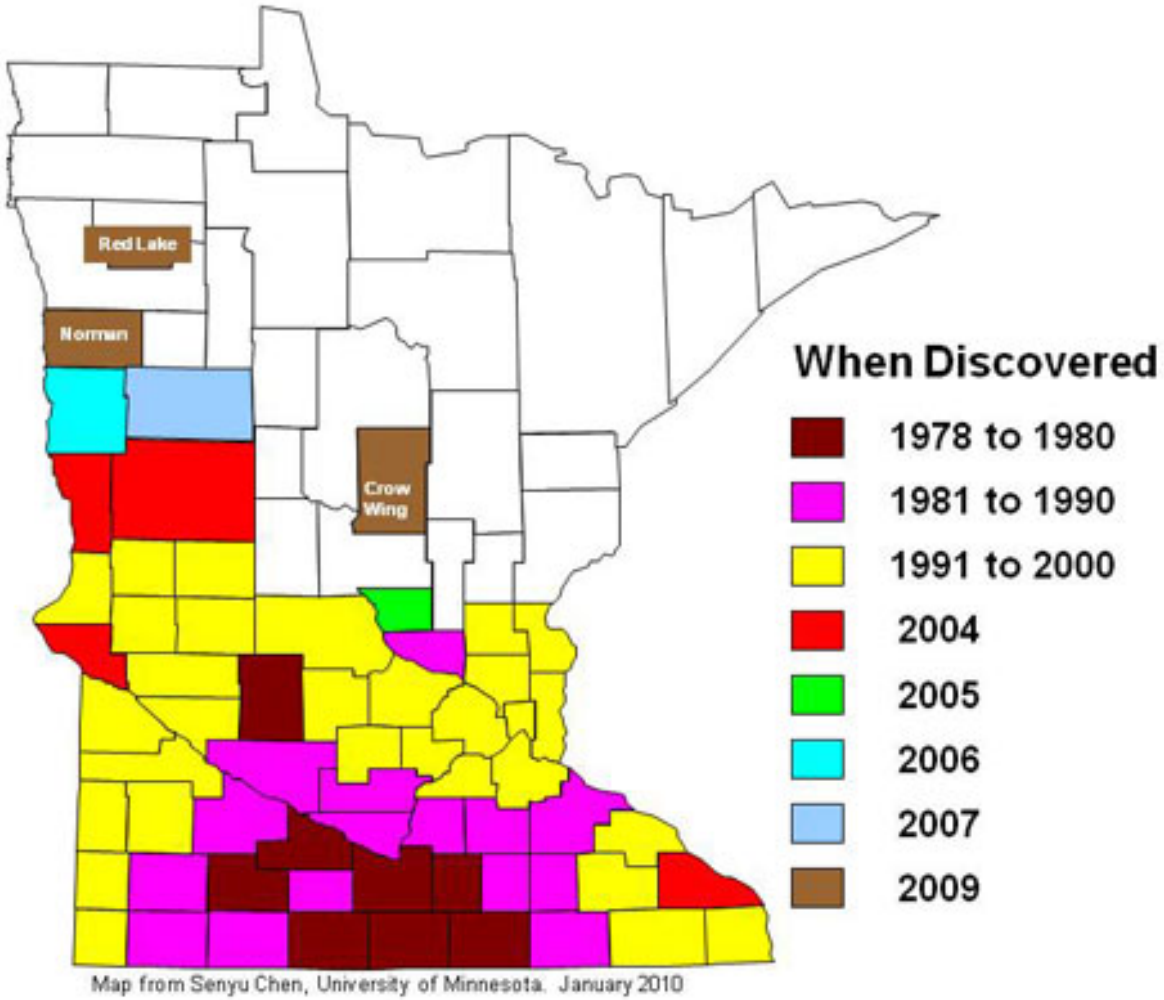
Soil Sampling for SCN

- Every third soybean crop year
- Sampling in fall following crop harvest and before soil freezes
- Following soybean harvest, sample directly within harvested rows before tillage
- Following other crops, sample after fall tillage, if you till
- Sample top eight inches
- Use a soil push probe or small diameter soil auger
- Take 15 cores for a sample from every 20 acres
- Sample specifically for trouble soybean area

More on Soil Sampling

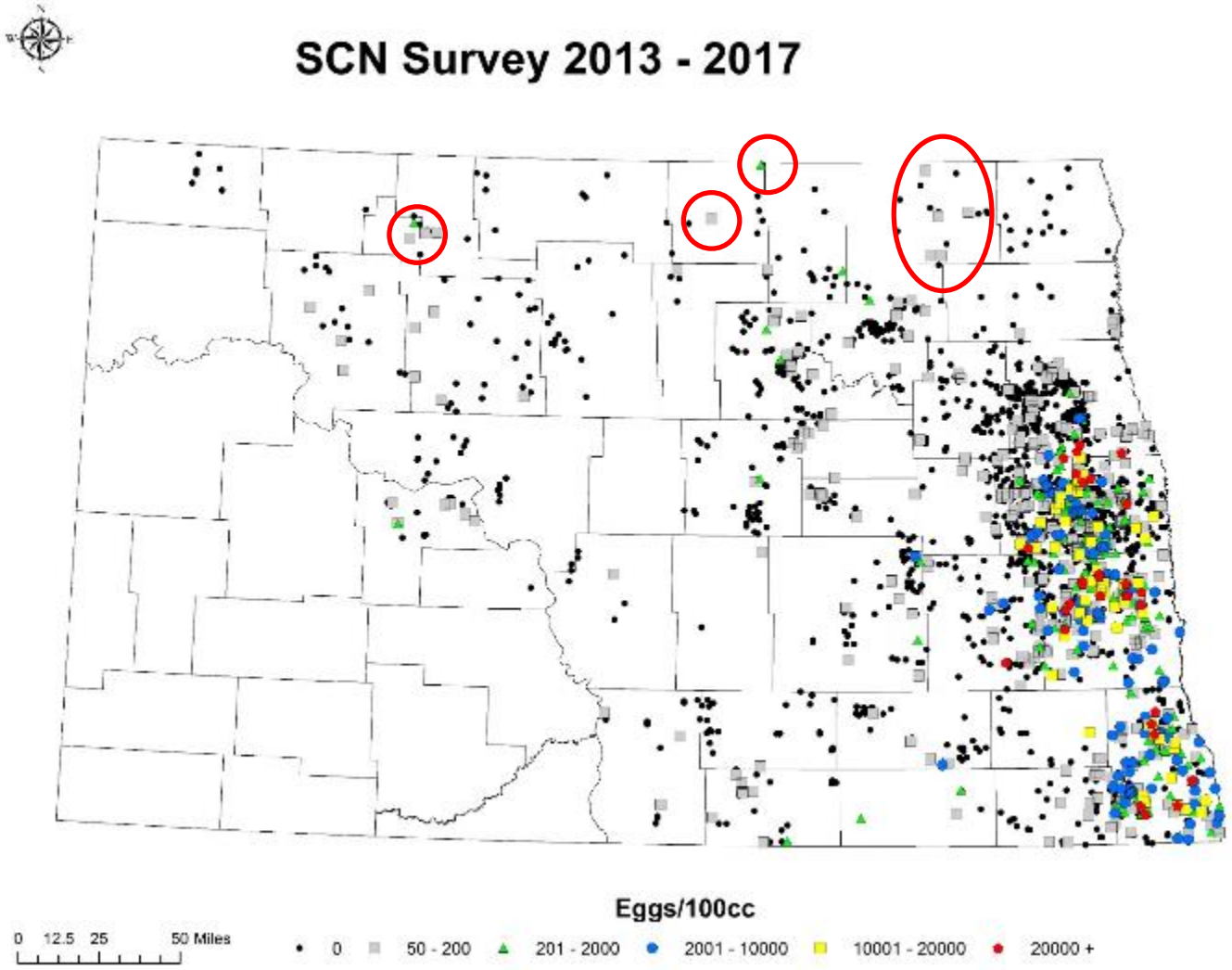
- Put cores into a bucket
- Mix the cores and place into a ziplock freezer bag
- Label both sides of bag with marker for name, legal, date, field sample number
- Keep bag out of sun
- Place in refrigerator
- Drop off samples to Agvise as you would do for soil fertility testing
- SCN is not a regulated pest, so call Mario if samples come back positive

SCN in Minnesota (2009)



Minnesota counties infested with soybean cyst nematode

SCN Survey in North Dakota



SCN and Manitoba

- Cysts with quality for morphological and molecular analysis belonged to genera *Punctodera* and *Cactodera*
- Likely not of economic conce but on weeds
- But!!! Most of Manitoba's +1,000,000 acres of soybean acres is relatively new to production, thus over next 5-10 years likely establishment of SCN in Manitoba